

TECHNIQUE OF EXPOSURE OF THE SPINAL CORD AND CANAL; OSTEOPLASTIC RE- SECTION AND LAMINECTOMY.¹

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THE object of the present paper is to discuss four aspects of the above title: The General Considerations of the Osteoplastic Resection of the Spine and of Lamineotomy, and their Relative Values; The Features common to both Operations; The Technique of Osteoplastic Resection of the Spine; The Technique of Lamineotomy; and under these four headings the subjects will be taken up in order.

Four of the drawings used to illustrate the present text have been modified from standard and acknowledged sources; one has been taken from the skeleton, and eight have been made from cadaveric operations.

I. *The General Considerations of the Osteoplastic Resection of the Spine and of Lamineotomy, and their Relative Values.*—In an osteoplastic resection of the spine, a composite flap, consisting of skin, fascia, one or more spinous processes, a set or more of corresponding laminae, and connecting ligaments, is partially excised *en masse*, with the constituent parts adherent, and temporarily turned backward and upward, hinging upon its own ligaments, thus exposing the portion of cord or spine involved, and is finally dropped back into its normal place at the conclusion of the operation, with practically all of its structures present and in natural relation. The soft parts are at no time detached from the spines, and only partly and temporarily detached from the laminae.

¹ Read before the Surgical Section of the New York Academy of Medicine, December 2, 1904.

In the operation of laminectomy, or lamnectomy, as it is variously called, the spinous processes and laminæ, with connecting ligaments, of two or more vertebræ, are completely freed from surrounding structures, excised, and permanently discarded. Where, as has occasionally been done, the spinous processes and laminæ are temporarily preserved in warm normal salt solution and replaced *in situ* at the end of the operation, the procedure is not, strictly, a laminectomy, but becomes a form of osteoplastic resection without all the good points of the latter done in a typical manner.

In performing laminectomy, an attempt, at least, should always be made to do the operation subperiosteally, unless there be some pathological contraindication. Many surgeons, however, never attempt to free the spines and laminæ of their periosteum before their excision, and in the majority of cases where it is undertaken, it may be safely said that the subperiosteal feature of the operation is carried out so imperfectly as to scarcely amount to a subperiosteal method at all, so great are the difficulties of preserving that membrane in clearing these small and irregular bones. In the osteoplastic resection there is no indication to work along subperiosteal lines.

The actual opening in the spine may be of practically the same size and shape in both operations; but the tendency is to form a narrower bony opening in laminectomy, and, of necessity, the field for manipulation is more contracted than in osteoplastic resection, owing to the much nearer approximation of the walls of the wound in the soft parts.

As to difficulty of execution, when one has practised both operations equally, no appreciable difference in the difficulty of technique, worthy of a determining consideration, is experienced.

It is not open to question that the laminectomy leaves a weaker spine than does an osteoplastic resection, for the latter leaves, practically, an intact spine, while the former leaves a spine minus as many spinous processes and laminæ, with their connecting ligaments, as have been cut out. Just how much

weaker laminectomy leaves the spine it would be hard to calculate; but it is self-evident that a whole spine is better than part of a spine, even if only one-quarter or one-third of two or three vertebrae have been permanently removed, and although the bone thus represented be replaced by fibrous tissue, or partly fibrous and partly bony. It is known that patients have sometimes not been able to sit upright, or to hold their heads up, after laminectomy. And many writers advise the wearing of a spinal support for some time after a laminectomy, which would indicate their belief in its need as an adjuvant to counteract the reduced strength of the column.

Weighing all considerations involved in the selection of one or the other method of approach, the choice of operation should, in the opinion of the writer, be unquestionably given to the osteoplastic resection, as an altogether more surgical procedure,—saving to the individual, as it does, practically all of his structures, all save one spinous process,—leaving, after union, an almost intact and necessarily stronger spinal column; affording a freer and fuller field for inspection and manipulation at the time of operation; furnishing greater subsequent protection to the spinal cord, and most probably furnishing also greater immediate protection to the cord by reducing, in shutting off the spinal canal, the chances of intraspinal infection in the event of non-primary healing.

As matters stand at the present day, and in view of the recent facilities for doing an osteoplastic resection, the view held by the writer is that in cases where the conditions will admit of an osteoplastic resection, the surgeon is not justified in performing any other operation for the exposure of the spinal cord or canal, and that, therefore, the mode of approach in such cases is not a matter of choice, but of plain indication. As the positions of the saw-cuts are practically the same in osteoplastic resection and laminectomy, it is hard to see where laminectomy would ever be indicated in preference to osteoplastic resection. Though such may be the case, no such specific instance occurs to one at the present time, except, possibly, in a rare case where the main object of the operation would be to permanently

remove, for pathological growth, the site of bone involved in a laminectomy,—or possibly in a case of great comminution of the spines and laminæ (and in such case the operation would be atypical),—or where traumatism of the soft parts had left no field for the U-shaped incision of an osteoplastic resection,—any of which possibilities would be encountered only most rarely. Whenever laminectomy is elected in preference to osteoplastic resection, there being no special indication for the former, the only partial justification there would seem to be for the performing of laminectomy would be that it be done subperiosteally, and, as already mentioned, there are those who feel that a subperiosteal laminectomy is very rarely accomplished, even when definitely undertaken by the skilful.

In spite, however, of these favorable aspects of osteoplastic resection, there is no doubt but that many more laminectomies than osteoplastic resections are still done. In the last editions of two of the most generally read works upon operative surgery published abroad, not only is osteoplastic resection of the spine not described, but not even mentioned, and no method of exposing the spinal cord and canal is given except the comparatively old-fashioned laminectomy.

It would seem that the explanation of this is that the technique of osteoplastic resection of the spine is so little understood, that so many operators, satisfied with laminectomy, have not convinced themselves that osteoplastic resection is better, proving to themselves the ease of this seemingly difficult operation by its performance several times upon the cadaver, and that the mechanical advantages afforded by Hartley's preliminary excision of the spinous process immediately above the flap, and the use of Doyen's saw, are not more generally known.

As far as the writer is personally concerned, he has done several laminectomies upon the living, and a number of osteoplastic resections, as well as laminectomies, upon the cadaver; and, with his present knowledge, he feels that the interests of the patient are better conserved if he be deprived of no appreciable part of his spinal column, and that the general surgical indications are best met by the osteoplastic resection. He did

not then do the osteoplastic operation for two reasons,—first, because of not knowing of a satisfactory instrument with which to make such a bone section; and, secondly, because of having no knowledge of the preliminary excision of the spine above the flap, without which the contiguous spines must interlock and prevent the satisfactory turning back of the flap, both of which difficulties are now readily overcome.

Before considering and illustrating the operations of osteoplastic resection and laminectomy in detail, there are aspects of the technique which are common to both operations and of a fundamental importance to their performance, and which will, therefore, be first mentioned and pictured as briefly as consistent with their understanding.

II. The Features common to both Operations.—(1) Preparation of Operation-site.—The region is shaved, whether visible hair be present or not, and is made aseptic by the special antisepic measures of the individual operator, the patient coming to the table with the part protected by dressings applied after the preliminary preparation, the final preparation being made at the time of operation.

(2) Position of Patient, Surgeon, and Assistants.—The patient lies upon a specially narrow table, in the semiprone position, as nearly upon the front of the chest as the conditions of anaesthesia will allow, being supported by cushions. The surgeon stands at the patient's back throughout most of the operation, passing to the opposite side of the table and leaning over the chest whenever it is more convenient to manipulate from that side. Two assistants are useful, one at the surgeon's side, and another opposite him, on the other side of the table, bending over the patient.

(3) Anæsthesia.—Nitrous oxide and ether, unless contraindicated for special reasons.

(4) Instruments and Accessories.—Heavy cartilage knife and medium knife; artery-clamp forceps; dissecting forceps; two pairs of special retractors with teeth blunt and long enough to reach the bottom of the wound; chisel about two centimetres (about three-quarters of an inch) wide;

Doyen saw; Gigli saw; probe with thin flat end; curved, heavy scissors for interspinous and interlaminous ligaments; small angular scissors for incising membranes of the cord; two small, toothed forceps for membranes; large and small needle-holders; fine, fully curved needles for membranes; heavy, curved needles for buried muscle sutures; straight needles for skin; plain fine catgut for membranes; twenty-day chromic gut for buried muscle sutures; silkworm gut, or silk, for skin sutures; horse-hair or catgut for intradural drainage; tubing or gauze for extraspinal drainage; gauze for packing wound; hot normal salt solution for haemorrhage.

(5) Landmarks of Operation.—The spinous processes corresponding with the laminæ to be removed should, if possible, be very clearly located before beginning the incision. This can always be done in backs of medium thickness, and generally in moderately thick backs upon deep pressure. The transverse processes in the dorsal and lumbar regions and the articular processes in the cervical region should also be located, in the case of the osteoplastic resection, if it be possible; but often cannot be determined until after the skin and fascia have been incised in the operation last mentioned.

(6) Manner of Incising Muscles and Aponeuroses.—While this is not a major point, attention to the principle involved will insure a more cleanly cut section in the case of osteoplastic resection, and a more complete clearing of soft parts from the spines in laminectomy than if the principle were not observed. One is familiar with the fact that the spines of a feather may be more readily and cleanly stripped from the quill by cutting from tip to base than by cutting in the opposite direction. Therefore will the section of muscles and aponeuroses be more cleanly and evenly made if made by a stout knife wielded in such a manner as to cut into, or towards, the more acute angle formed by the attachment of the muscular or aponeurotic fibres to the parts of the vertebral column, rather than towards the more obtuse angle; and especially is this the case the nearer the spinous processes one approaches. This will sometimes necessitate cutting towards

the head, sometimes towards the sacrum, according to the direction of the fibres at the site of operation, and may require stepping to the opposite side of the table. Practically, two changes in the direction of the incision on either side of the median line will fulfil these indications. It will, therefore, be seen that it is not advised to cut from skin to bone or even from fascia to bone, at one stroke, but rather with three,—one through skin and fascia and two through the musculo-aponeurotic structures,—retracting between each incision, such a procedure furnishing a wound with less raggedly cut walls (Fig. 1, A, B).

(7) *Manner of Clearing Soft Parts from Spines and Laminæ.*—This, as usually done, is accomplished by the combined use of cartilage knife, periosteal elevator, and raspatory, with more or less satisfactory result. The cleaning of the bones may, however, be much more thoroughly done, and by a single instrument, by using an ordinary chisel. When the incisions have been carried fully to the bones, a knife is no longer necessary. Through the incision made by the knife, a chisel (about two centimetres, or about three-quarters of an inch, wide) is carried directly to the depth of the wound, guided, if necessary, by the surgeon's left index-finger, and so directed that its bevelled edge will be turned away from the soft parts to be pried from the bones. In osteoplastic resections the blade of the chisel rests against the transverse processes in the dorsal and lumbar regions, and against the articular processes, partly covered by muscles, in the cervical region, and, from these as fulcra, the soft parts are levered off towards the spines (Fig. 6, D). In a laminectomy the chisel-blade rests against the spinous processes, and from these as fulcra the soft parts are pried out of the bony groove towards the transverse processes in the dorsal and lumbar regions, and articular processes in the cervical (Fig. 10, C). This use of the chisel is exceedingly satisfactory, its sharp edge easily and thoroughly removing all the soft parts, and probably leaving a cleaner bony bed for the saw than is accomplished in any other way. This result is not so well secured if the bevel of the chisel is turned towards the parts to be removed.

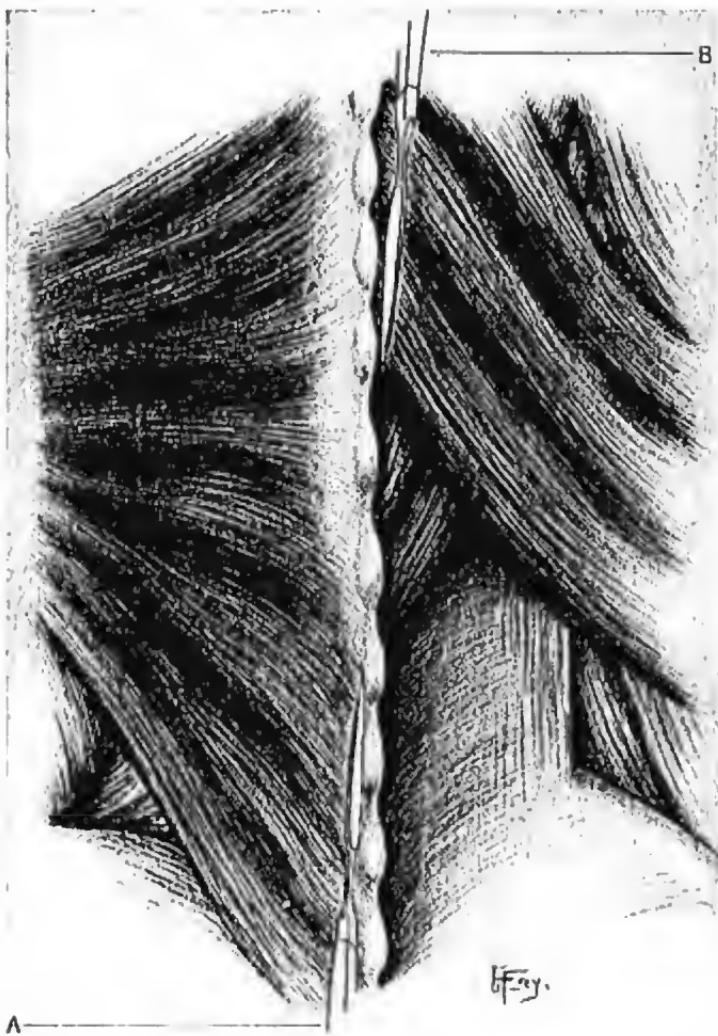


FIG. 1.—Muscles of dorsal region of back, showing manner of incising muscular and aponeurotic fibres. A, Incision of lower part of trapezius downward into the acute angle formed by its fibres with the spine; B, incision of underlying rhomboid muscles upward into the acute angle formed by their fibres with the spine. (Modified from Gray's Anatomy.)

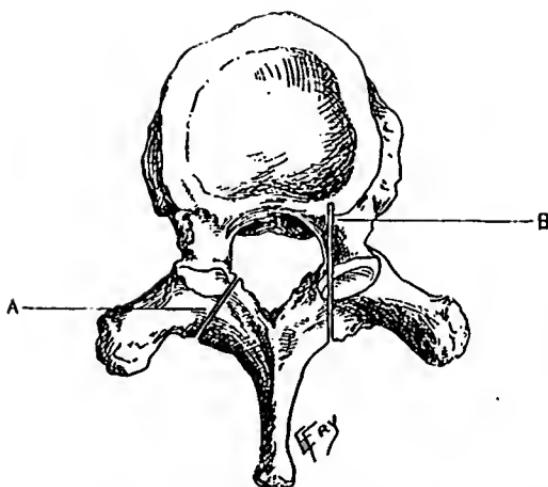


FIG. 2.—Dorsal vertebra, showing results of incisions begun at relatively corresponding sites and passing through laminae in different directions. A, Proper section, cutting lamina at right angle to its surface and entering spinal canal; B, improper section, passing through lamina parallel with general direction of spinous process and entering pedicle of vertebra and on into body. (Modified from Quain's Anatomy.)

(8) Manner of Dividing the Laminæ.—This step, in either operation, is of paramount importance, and the manner of its performance, as far as the actual making of the saw-cut is concerned, is the same, whether the operation be osteoplastic resection or laminectomy. And the principle is also the same, as far as the direction of the section is concerned, no matter with what form of instrument the division of bone be made. This important principle is that the instrument should have its edge placed upon the laminæ at or a little to the outer side of their centre, and be made to cut its way through the laminæ strictly at a right angle to the general direction of their surfaces (Fig. 2, A). Even if the edge of the bone-cutting instrument enter in about the same site as just described, and the section be made, as so often done by beginners, parallel with the general direction of the spinous processes, the chances are that the section will pass on into the solid articular processes and pedicles, and, if continued, on into the bodies of the vertebrae (Fig. 2, B). The writer has observed the marked tendency to this serious error upon the part of students, who really often do not appreciate their difficulty until it is pointed out to them upon the skeleton. The error, once made, is hard to correct; it is absolutely impossible to go ahead upon that straight line; it is hard to start a new saw-cut, and often, much chagrined, one is at a loss to know what to do and is tempted to chisel his way through. It is better, however, to persevere with the saw until the groove of a new cut is made in the right direction.

(9) Instrument for Making the Bone-sections.—Doyen's saw, in the judgment of the writer, is the instrument, *par excellence*, for all bone-sections which are necessary in exposing the spinal cord and canal. It is useless to more than mention the many means that have been resorted to to divide the parts of the vertebrae, such as excision of the spines with bone-pliers, followed by cutting away the laminæ with bone-cutting forceps, or sawing them off with Gigli or chain saw; dividing the laminæ directly by bone-cutting forceps, one blade of which has been thrust through an interlaminous ligament; chiselling

through the laminæ in parallel lines (at the cost of much jarring and irregular division); the use of small trephine-openings, the intervening laminæ being cut away, and the use of the Hey saw. Doyen's saw is, practically, a Hey's saw with an adjustable guard, and while it seems a rather unsatisfactory instrument for the purpose intended by its author (namely, cutting through the skull between the burr-openings in cranial work), it is an almost perfect instrument for work upon the spine. The writer has had no experience with motor saws in this connection, nor seen any at work upon the spine, and while inclined, on principle, to that form of saw, he knows at present of no instrument more admirably adapted for special work than the Doyen saw for spinal sections (Fig. 3).

(10) Hartley's Preliminary Excision of the Spinous Process immediately above the Flap in Osteoplastic Resection of the Spine.—While this procedure is not common to both osteoplastic resection and laminectomy, and consequently does not strictly come under this division of the subject, yet it is a fundamental feature of the osteoplastic resection, and its general principles will, therefore, be briefly described here. It is difficult to see how an osteoplastic resection is possible without first removing the spine immediately above the flap to be turned back. Most markedly in the dorsal region, and even in the cervical and lumbar regions, will any lower spine quickly become interlocked with the one just above if an attempt be made to turn it backward and upward. So that without the preliminary excision of the spine above, the flap below can only be turned backward and upward by main force, and often a considerable degree of force is necessary, during the exercise of which bony portions of contiguous vertebrae may be broken, or other damage done. This preliminary step to the main operation may, therefore, be regarded not only as a most useful feature, but almost as a *sine qua non* of the operation as a whole. The manner of its execution will be described more in detail under the osteoplastic resection.

(11) Control of Hæmorrhage.—The three stages at which hæmorrhage is apt to be encountered are: after making



FIG. 3.—Doyen's saw, the guard set at 10 mm. (3 in.) (Modified from The Kny-Scheerer Company's Catalogue.)

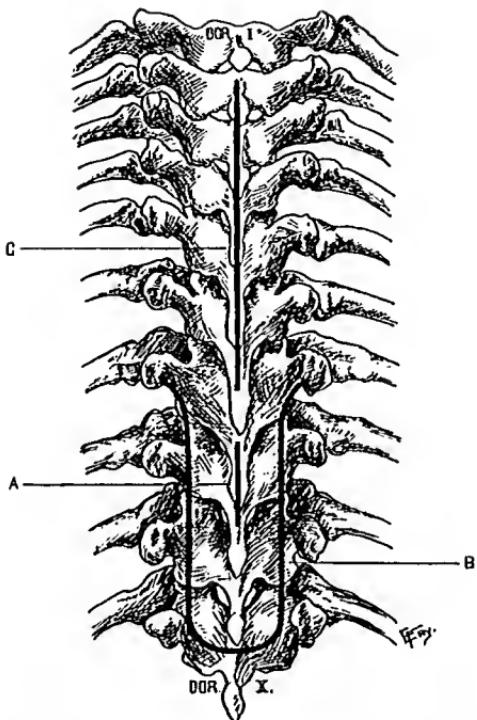


FIG. 4.—Lines of skin incisions in relation to underlying bones in osteoplastic resection and in laminectomy. A, Line to remove seventh dorsal spine in Hartley's preliminary operation of excising the spinous process of the vertebra immediately above those forming part of the osteoplastic flap; B, modified U-shaped incision outlining the osteoplastic flap for turning back the eighth and ninth dorsal spines and laminae; C, line of incision for laminectomy of third, fourth, and fifth dorsal spines and laminae. (Drawn from the skeleton.)

the skin and fascial wound; during the incision of the muscles of the back; and after opening the spinal canal, in removing or incising the vascular fatty areolar tissue from around the membranes. Haemorrhage from visible vessels encountered prior to reaching the spine should be controlled by artery-clamp forceps, followed by ligature or torsion. General oozing and haemorrhage from undetectable sources (which form the chief bleeding) should be arrested by gauze packing, or by flushing with hot normal salt solution, and by alternately working upon the two sides of the wound. Intradural bleeding from the vascular fatty areolar tissue surrounding the cord, and which is chiefly venous, should be stopped by pressure with gauze held in forceps.

III. The Technique of Osteoplastic Resection of the Spine.—Two distinct operative steps are here undertaken,—the preliminary excision of the spinous process above the flap, and the formation and turning-back of the osteoplastic flap. The nature of the operation has been briefly described under General Considerations.

(A) Preliminary Excision of the Spinous Process immediately above the Osteoplastic Flap (Hartley's Operation).—This preliminary operation may be considered under the following headings: Incision; Exposure of Spinous Process; Severing of Supra- and Inter-spinous Ligaments; Excision of Spine; Temporary Packing of Preliminary Wound; Final Suturing of Preliminary Wound.

(1) Incision.—A vertical incision is made directly in the median line; its centre over the spinous process to be excised, and extending in length from the tip, or near the tip, of the spine above to the tip, or near the tip, of the spine below (Fig. 4, A).

(2) Exposure of the Spinous Process.—The above incision is carried through skin and fascia directly onto the spinous process mentioned. The lips of the wound are then well retracted, and the spine in question is exposed fully to its base by prying away the overlying and closely attached soft parts by means of a chisel used against the spine as a fulcrum,

in the special manner described under General Considerations. This freeing having been accomplished, the soft parts are strongly drawn aside by means of retractors, which also serve the part of protectors of the soft parts during the use of the saw (Fig. 5, A, A). A subperiosteal exposure of the spine should be attempted.

(3) Severing of Supra- and Inter-spinous Ligaments.—These ligaments are now to be divided, both in order to sever this spine from the one below and to prepare a passage for the Gigli saw. This division of ligaments may be made with a knife, but can be better and more readily accomplished by means of curved scissors whose concavity is held upward. Having passed through the supraspinous ligament, the inter-spinous ligament is divided down to the ligamenta subflava. The spinal canal should not be opened in this procedure.

(4) Excision of the Spinous Process.—A passage-way having been thus provided, a Gigli saw is carried deeply down to the very base of this spinous process and the entire process removed (Fig. 5, B, B). Care is exercised to avoid making but a partial excision, as the remaining stump may interfere with the turning back of the flap almost as much as though the entire spine were *in situ*. Some operators cut the spine off with bone-cutting forceps; but the use of bone-cutting pliers here, as in many other instances, is unsurgical, removing, as they do, by a crude process of crushing, a part of bone which is much more cleanly and less traumatically cut away by a Gigli or other form of saw.

(5) Temporary Packing of the Preliminary Wound.—The spine of bone having been removed, the preliminary operation is for the time-being ended. The further use of this wound will be described in connection with the turning back of the osteoplastic flap. Some operators here permanently suture up the wound left by the excision of the spinous process; but it is distinctly best not to do so, as will be evident farther on. This wound should be tightly packed with gauze and temporarily left alone.

(6) Final Suturing of the Preliminary Wound.—At the



FIG. 5.—Osteoplastic resection of the spine; Hartley's preliminary operation for excising the spine of the vertebra immediately above the flap. A, A, Retractors in the wound, also serving as protectors of soft parts; B, B, Gigli saw in position for excising the entire spinous process. (Drawn from cadaveric operation.) Note.—The subperiosteal method is not shown here.

conclusion of the entire operation, the preliminary wound is sutured upon the same general principles to be described for the main wound, namely, buried chromic gut sutures to bring the muscle and aponeurotic structures together in the space formerly occupied by the now excised spinous process, and silkworm gut, or silk, for the skin wound, no drainage being used (Fig. 9, A, A).

(B) The Formation and Turning back of the Osteoplastic Flap.—This, the main operation, will be considered under the following divisions: Incision; Division of Muscles and Aponeurosis; Freeing of Laminæ preparatory to their Division; Division of Laminæ and Ligamenta Subflava; Division of Supraspinous, Interspinous, and Interlaminous Ligaments; Separation and Turning back of Osteoplastic Flap; Freeing of Spinal Cord from Extradural Fatty Areolar Tissue and Control of Intraspinal Haemorrhage; Opening of Membranes of Cord; Manner of Dealing with Incised Membranes; Reposition of Cutaneomusculo-ossous Flap; Deep Buried-suturing of Muscles and Aponeuroses; Skin and Fascial Suturing; Provision for Drainage when Indicated; After-treatment; Comment.

(1) Incision.—A modified U-shaped incision is used. This incision outlines the two sides and lower limit of the composite flap of skin-muscle-aponeurosis-bone-and-ligament to be temporarily turned back (Fig. 4, B). Its two strictly vertical limbs begin over the laminæ of the vertebral whose spine is to be excised, commencing to the outer side of its vertical centre, near the root of the transverse process in the dorsal and lumbar regions, and near the base of the articular process in the cervical vertebrae, and extend, on both sides, downward in straight lines, parallel with the tips of the spinous processes, until opposite the tip of the last spine to be included in the resection; here the incisions broadly curve towards the median line, meeting midway between the tip of the spinous process just mentioned and the tip of the spinous process next below. It is very essential that this broad curve should be given to the lower end of the incision rather than that a narrow contracted

curve be made, much of the ease of subsequent manipulations depending thereon. For the purpose, solely, of providing a greater influx of blood into the base of the semidetached flap of skin-muscle-and-bone, a slightly outward curve should be given to the upper ends of the vertical portions of the U-shaped incision. It might be asked how the bases of the transverse processes of the dorsal and lumbar vertebrae and the bases of the cervical articular processes may be recognized prior to the skin incision; in reply to which it may be said that the tips of these processes themselves (transverse and articular) may generally be felt upon firm pressure made upon backs of medium thickness, and, having recognized the tips of these processes, their corresponding bases lie approximately midway between their tips and the median line formed by the apices of the spinous processes. Where the tips of the transverse processes of the dorsal and lumbar vertebrae and tips of the articular processes of the cervical vertebrae cannot be recognized by palpation at all, it may be stated that the tips of the transverse processes of the dorsal vertebrae lie, in the average skeleton, about three to 3.5 centimetres (one and one-fourth to one and three-eighths inches) from the tips of the dorsal spines, the tips of the lumbar transverse processes about four to five centimetres (one and five-eighths to two inches) from the tips of the lumbar spines, and the tips of the cervical articular processes about three centimetres (one and one-fourth inches) from the centres of the cervical bifid spines.

(2) Division of the Muscles and Aponeuroses.—The direction of the incision through the layers of muscles and aponeuroses at the different layers, and the reasons therefor, have been given above under General Considerations. The incision through skin and fascia will, upon retraction, have exposed muscle or aponeurosis, according to the site of operation. The margins of the skin and fascial wound having been retracted and haemorrhage controlled, the muscular and aponeurotic layers in view are incised in a general direction which will correspond with the acuter of the two angles which their component fibres make with the spine, and the layers below

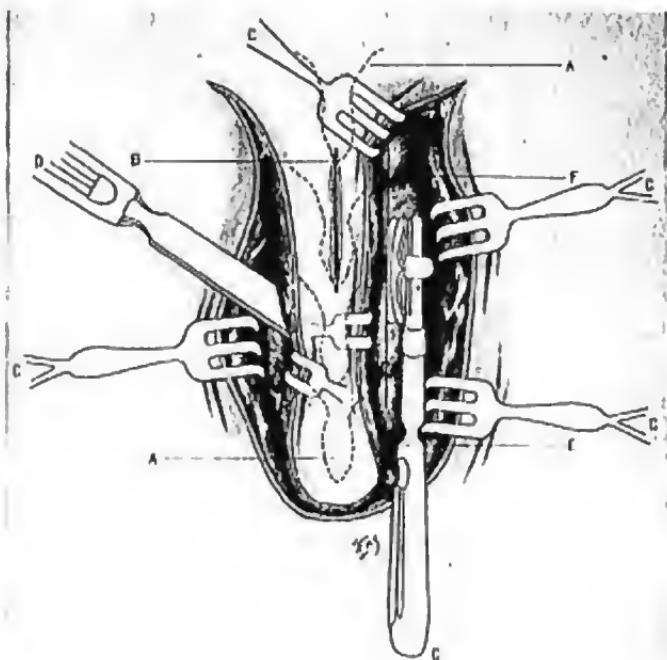


FIG. 6.—Osteoplastic resection of the spine. A, A, Position of dorsal spines; B, wound of Hartley's preliminary excision of spinous process immediately above flap; C, C, C, C, retractors of main wound; D, chisel, against transverse processes as fulcra, in act of prying soft parts from laminae; E, lamina; F, interlaminous ligament (ligamentum subflavum); G, Doyen's saw in act of completing section through laminae and interlaminous ligaments. (Drawn from cadaveric operation.)

similarly incised. Immediately prior to deepening the muscle incision down to the bone, it is advisable to satisfy one's self, by means of a finger introduced into the wound, that the vertical limbs of the U-shaped incision are falling well within the bases of the transverse processes in the dorsal and lumbar regions and within the tips of the articular processes in the cervical region. This precaution will insure the coming of the incision down upon the spinal column over the laminæ, which will make the clearing of the laminæ correspondingly easy.

(3) Freeing the Laminæ preparatory to their Division.—The gauze packing is now removed from that side of the U which was first incised and packed, by which time the haemorrhage, which is usually rather free, has ceased. While instrumental retraction should be practised during the latter stage of the freeing of the laminæ, it is not necessary, and is certainly better omitted during the beginning of the freeing, owing to the small amount of room in the wound for finger and chisel. At the stage when retractors are used, they should have blunt hooks, to avoid wounding the fingers of operator and assistants, which are also in the wound; and they should be long enough to reach to the bottom of the incision. Proceeding, therefore, at first without retractors, the left index is introduced into the wound until its tip is in contact with the laminæ. An ordinary chisel, as mentioned in the Introduction, is now inserted alongside of the already introduced finger, with its edge parallel with the direction of the spines and with the bevel turned away from the parts to be pried from the laminæ, in the manner already described. A path for the Doyen saw is thus made over those laminæ which are to be temporarily turned back,—the chisel being used as a lever,—braced against the transverse processes in the dorsal region, against the articular and transverse processes in the lumbar region, and against the articular processes in the cervical region, and, with these as fulera, is made to pry the overlying soft parts from the bony groove formed by the laminæ and interlaminous ligaments (Fig. 6, D). While the major portion of this clearing of the saw-bed can be accomplished by manipulating the chisel from the aspect

of the transverse and articular processes towards the base of the spines, a still more thorough completion of the clearing can be secured by withdrawing the chisel, turning it around (so that the bevel is towards the transverse processes), and also using it against the spines, covered by their soft parts, as fulcra, while prying away from the laminæ those soft parts lying nearer the transverse and articular processes. This manipulation is shown in Fig. 10, C, where the principle is used in the laminectomy operation. Not only should the special laminæ and interlaminous ligaments involved in the resection be completed cleared of overlying soft parts, but the lower half of the laminæ above and the upper half of the laminæ below these should also be freed, as it will be necessary for them to accommodate the end of the saw in its excursions. This additional clearing is shown in Fig. 6. When the saw-bed upon one side has been thus prepared, it is firmly packed with gauze, to control bleeding, while the opposite side is being similarly prepared and packed.

(4) Division of Laminæ and Ligamenta Subflava.—The edges of each of the vertical limbs of the wound should be retracted, one at a time, by four special retractors with extra-long blunt teeth, the wound thus presenting a rectangular shape (Fig. 6, C, C, C, and a small unlettered retractor). The guard of the Doyen saw is set at ten millimetres (about seven-sixteenths of an inch), which will give a sufficient cutting edge to pass completely through the laminæ at any portion of the spine, provided the section be made well within the laminæ proper, and at a right angle to their surfaces. With the guard thus set it is simply impossible to wound the cord (the cord and spine being normal), as the saw will bind after traversing the bone. As a matter of fact, the guard may be entirely dispensed with; though under such circumstances care is necessary, and the saw must be checked immediately upon the sense of lost, or lessening, resistance, as the last thickness of the laminæ is encountered. One has frequently thus used the saw upon the cadaver without other than the most ordinary precautions, and has never seen injury done in such cases; nor

has he but once ever seen the cord injured by a student during the roughest manipulation, independently of the form of instrument used for the bone division, so securely is the cord ordinarily protected by its position. The saw, protected by the guard at ten millimetres, should be used until it has cut its way completely through and is stopped by the shoulder of the guard. The sweep of the saw at each stroke should be as full as the length of the wound will allow; and the general cutting edge of the saw should be held as level as circumstances will permit, that the bone-section may be made of equal depth throughout as great a length of the wound as can be reached in one position of the saw. It is usually impossible to complete the section of one side with the saw in one position, owing to the shape and position of the handle of the saw, as the end of the saw nearer the handle will not travel the full length of the wound quite as satisfactorily as the distal end. Fig. 6, G, illustrates this principle. The surgeon, therefore, standing at the patient's back, introduces the saw first into one side and then into the other, using the instrument from below upward and sawing through the lower half of the laminae above those to be turned back, as well as through as many of the laminae to be resected as the teeth of the saw will engage themselves in. When division of the upper parts of both sides has been made, the surgeon, unless ambidextrous, must walk around the table, lean over the thorax of the patient (in his semiprone position), and, sawing now from above downward, complete the section of those laminae to be temporarily turned back, as well as of one-half of the laminae next below. The depth of the bony section may be tested from time to time by means of the flat end of a specially thin probe. This division of one-half of both the laminae above and below those to be temporarily displaced is only necessary because unavoidable, as the saw-blade cannot be carried abruptly up to the limit of one lamina and completely divide it without also at least partly dividing a portion of the contiguous lamina (Fig. 6, E). But no practical harm is done thereby, as only a very small proportion of these two sets of laminae is divided by the very fine blade of the saw,

and must soon solidify. The ligamenta subflava are also divided by the saw (Fig. 6, F).

(5) Division of the Supraspinous, Interspinous, and Interlaminous Ligaments.—The lowest one of the spines in the osteoplastic flap, with its corresponding laminae, is now to be severed from the corresponding intact structures next below, involving the division of the above-mentioned ligaments. These ligaments may be divided with a knife held sidewise, but are more satisfactorily divided by a pair of curved scissors held with their concavity backward (Fig. 7, C). The process of division is aided by grasping the composite flap to be displaced and lifting the lowest spine away from its neighbor next below, thus giving the scissors more room for dividing the V-shaped ligamentous structure formed by the supraspinous and interspinous ligaments posteriorly and the ligamenta subflava to either side.

(6) Separation and Turning Back of the Osteoplastic Flap.—The detachment or loosening of the resected portion of the spinal column is best accomplished by means of the same chisel used in clearing the soft parts from the bones, and held in the same way, that is, with the non-bevelled edge towards the part to be pried out. Preparatory to thus using the chisel as a lever, the edges of one of the vertical limbs of the wound are retracted by the four special retractors mentioned above (Fig. 7, A, A, A, and a small unlettered retractor), the parts sponged dry with gauze, and the saw-cut brought well into view. The surgeon's left index-finger should be introduced into the preliminary wound through which the spinous process has been removed (Fig. 7, B), carried down to its sawn-off end and adjacent interlaminous ligaments, and held there until the composite flap has been pried out of its site, the tip of the finger greatly aiding in this manœuvre and in determining the progress of the elevation. The chisel is placed in position, with its bevelled side against a transverse process (in the dorsal or lumbar region) or against an articular process in the cervical region, and its edge, with non-bevelled surface towards the spines, engaged in the saw-cut (Fig. 7, D). The composite

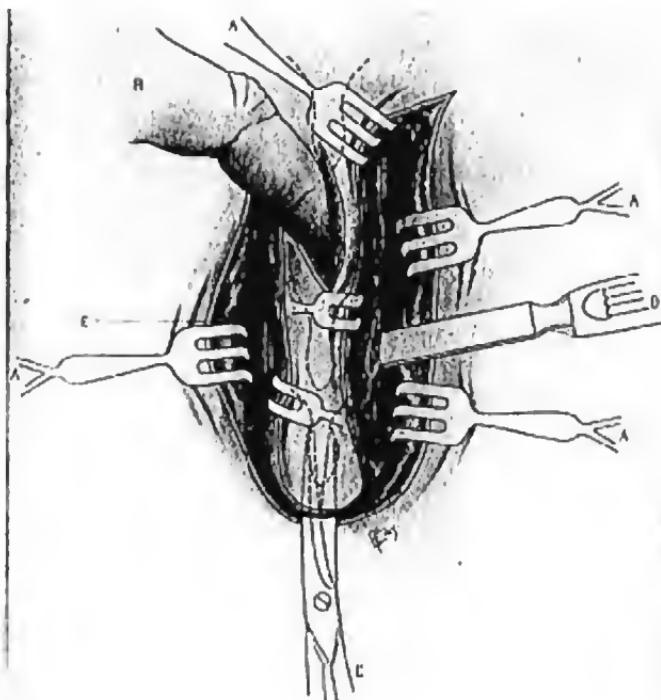


FIG. 7.—Osteoplastic resection of spine. A, A, A, A, Retractors in main wound; B, surgeon's left Index-finger introduced into preliminary wound to aid in bending back of flap; C, curved scissors cutting interspinous and interlaminar ligaments; D, chisel introduced into saw-cut and supported against transverse processes as fulcra, prying out osteoplastic flap; E, opposite saw-cut. (Drawn from cadaveric operation.)

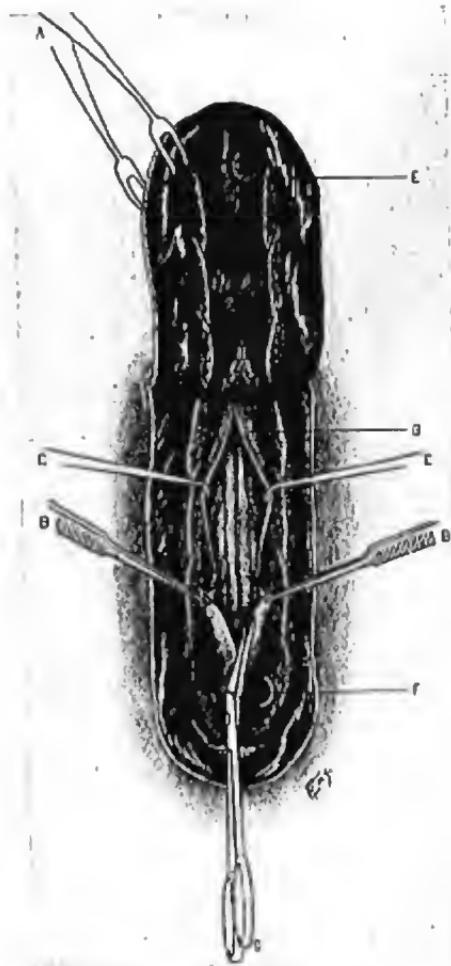


FIG. 8.—Osteoplastic resection of the spine. A, Tenaculum-forceps holding back composite flap; B, B', delicate forceps grasping and elevating membranes and forming a transverse ridge; C, C', tenacula holding apart edges of incised membranes; D, angular scissors used in incising membranes; E, half-button of bone bitten out of lower margin of last lamina in flap by rongeur forceps; F, similar half-button bitten out of upper margin of next stationary lamina below, the two half-buttons forming a circular opening, when in contact, for drainage; G, vascular fatty areolar tissue covering membranes. The stump of the excised spine is shown, in impression, through the turned-back flap. (Drawn from cadaveric operation.)

mass is seized between the surgeon's left thumb and index and steadied and gently drawn away during the prying-out process. Ordinarily, a single, light, downward pressure of the handle of the chisel will suffice to start the composite flap from its normal site, after which the entire flap can be readily turned back. This is always so if the section of bones and ligaments have been previously made complete, which should invariably be the case, and verified by sounding along the entire line of section with the flat end of a thin probe. Should the flap not readily, and without force, start backward, it argues that the section has not been fully made; and there is no alternative but to lay down the chisel and complete the division of bone with the Doyen saw, or of the ligaments holding the last spine and laminæ with scissors, as may be indicated, before going on with the levering-out process. As soon as the section is felt to be started from its bed sufficiently to get the end of the finger under the tip of the lowest one of the spinous processes, all instruments may be laid aside. With the left index-finger still in the preliminary wound through which the spine has been removed, pressing down between the stump of the excised end and the upper margin of the laminæ below, and with the right index under the last spine of the flap, the entire mass is turned backward and upward onto the patient's back (Fig. 8, A). The backward displacement of this flap is accomplished in the following way: The mass hinges over the stump of the excised spinous process, the interlaminous ligaments serving as the hinge; at the maximum of tension of the parts the upper border of the detached laminæ below is pried downward and outward from under the lower border of the intact laminæ above, and then slightly rides up over the latter in the turning-back process. This manœuvre does not so fully occur in the lumbar region, and but slightly, if at all, in the cervical region, owing to the different disposition of these laminæ and their wider separation from each other. If the line of bone-section have fallen well within the articular processes, the joints of the articular processes will not be opened. This manipulation, though exercising some violence upon the structures entering

into the make-up of the interlaminous relations at the hinge, does no permanent harm, as the parts readily drop back into their normal relationship at the end of the operation and undoubtedly soon solidify. The composite flap, once turned back, will generally lie *in situ* without restraint, or may be held so with a light retractor or tenaculum-forceps (Fig. 8, A).

(7) Freeing of the Spinal Cord from the Extra-dural Fatty Areolar Tissue, and Control of Intraspinal Haemorrhage.—Having turned back the osteoplastic flap, the window in the spinal column is shown, corresponding in length with the number of laminae resected, and in width with the distance apart of the saw-cuts (Fig. 8). In some cases the membranes of the cord lie readily within view and touch through the window thus formed, surrounded by a minimum of connective tissue. In other cases a more or less thick layer of vascular fatty areolar tissue may intervene between the bone and the cord (Fig. 8, G). To reach the membranes, this layer must be removed, which is best accomplished by grasping it with delicate forceps and cutting it with fine angular scissors. The haemorrhage which results from this manœuvre, and which may be somewhat marked, is usually readily controlled by the pressure of gauze held in small forceps. The haemorrhage will be less if this vascular tissue, chiefly venous, be cut accurately in the median line. Upon the removal of this fatty connective tissue the white glistening membranes of the cord are brought into the field. If the object of the operation have been only to expose the membranes, that object is now accomplished. If the cord itself is to be exposed, other steps are necessary.

(8) Opening of the Membranes of the Cord.—The most satisfactory manner of incising the membranes which the writer has found is the following: Two pairs of delicate, toothed forceps are taken, one held in the surgeon's left hand and one in an assistant's right hand (Fig. 8, B, B); each of these, on the same level, takes a light hold upon the membranes of the cord about three millimetres (approximately one-eighth of an inch) from the median line of the membranes (making the forceps six millimetres, or one-fourth of an inch, apart), care

being taken that the membranes alone are grasped. The tips of the forceps are now drawn gently outward and upward, away from the underlying cord, whereby a marked transverse ridging of the membranes is produced at a right angle to the length of the cord. While thus held, this ridge is cut with the points of a pair of small, angular scissors held in the right hand of the operator (Fig. 8, D). Having made an opening in the membranes, the lower blade of the scissors is passed along between the cord and theca, and the incision extended to the desired length, the holds of the forceps being shifted as the incision advances, and being subsequently maintained to retract the incised membranes, or the edges of the cut theca may be held apart with fine tenacula (Fig. 8, C, C). Upon the wide retraction of the cut membranes the spinal cord and the exit of the nerve-roots from the cord are brought well into view. The special object of the operation, if it involve the cord, is now carried out. The present paper deals solely with the manner of exposing the cord and canal, the various special conditions for which this exposure may have been made not being taken up.

(9) Manner of Dealing with the Incised Membranes.—This will pre-eminently depend upon the nature of the special operation. All bearings of the operation being favorable, it is best to close the membranes after the carrying out of the special object in view. This is done with fine, plain catgut threaded upon a specially adapted, fully curved needle held in an appropriate needle-holder. The margin of each lip of the cut theca is brought into proper relationship for suturing by being held by the delicate toothed forceps used in steadying the membranes during the incision of its structures. A continuous suture completely closing the incision is preferable.

(10) Reposition of the Cutaneomusculo-osseous Flap.—The object of the operation, as a whole, having been fulfilled, the composite flap will often fall back into accurate apposition without any effort to make it do so. It is, however, better for the surgeon to reinsert his left index into the preliminary wound through which the spinous process has been excised and

carry this finger down to the stump of the excised spine (Fig. 7, B), while with his right hand he replaces the flap, thus having a better opportunity to verify the accurate fitting of the parts. This fitting of the structures back into their original relationship should be absolute; and, fortunately, it is easy to determine whether or not it is so, and equally easy to make it so if there seems to be difficulty. This replacement is brought about by manual manipulation alone, the left index in the small wound guiding the parts at their hinge-junction. The accuracy of the apposition is verified by exposing the saw-cuts, and seeing that the parts of the laminae on either side of the section line are on an exaet level; and, when this is the case, it will be found that the shelving surfaces of the contiguous laminæ, where the interspinous and interlaminous ligaments were cut, are in accurate apposition, that the spines are in line and on a level, and that the skin margins come easily and evenly together.

(11) Buried Suturing of Muscles and Aponeuroses.—Having readjusted the composite flap, the soft parts intervening between skin and bone should be brought together by deeply buried sutures (Fig. 9, C). One would give the preference to twenty-day chromic gut, fairly stout, carried upon a fully curved needle. The cut muscles and aponeuroses are brought together in their proper layers and relations in the bite of heavy forceps, and are thus held while being penetrated by needle and suture. Two continuous sutures may be used, each passing from the upper end of one of the limbs of the U-shaped incision above to the centre of the incision below, or interrupted sutures may be applied. It is not practicable to suture together the cut edges of the interspinous and interlaminous ligaments, nor is it necessary, so closely do the parts come together, but the cut ends of the supraspinous ligament may be sutured.

(12) Skin and Fascial Suturing.—The skin and fascia should have their edges united with interrupted sutures of silkworm gut or silk. A continuous suture of a wound of this shape and extent is not apt to bring the margins so accurately together (Fig. 9, D).

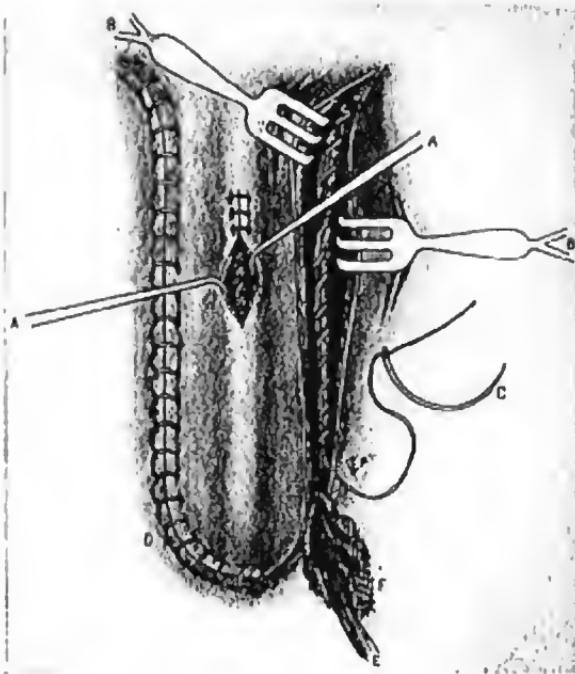


FIG. 9.—Osteoplastic resection of the spine. A, A, Retractors in preliminary wound, showing buried sutures of muscles and superficial sutures of skin; B, B, large retractors drawing back skin of main wound; C, line of continuous buried sutures of deeper parts; D, line of interrupted superficial sutures; E, intradural horse-hair or catgut drains; F, extra-spinal gauze drain. (Drawn from cadaveric operation.)

(13) Provision for Drainage, when indicated.—Opinions differ upon the subject of drainage,—some advising its use both within the membranes and in the extraspinal wound, and some its non-use. Unless there were some special contraindications, the preference of the writer would be to completely and accurately suture the incised membranes; to shut off infection from without, and the escape of cerebrospinal fluid from within; to introduce, for from twenty-four to forty-eight hours, an intraspinal but extradural drain of a few strands of horsehair, or catgut, bringing these out between a couple of omitted superficial sutures (Fig. 9, E), incorporating them with a strip of gauze placed in the deep muscle wound and leading down to the spine (Fig. 9, F), both emerging together from the skin wound. Where intraspinal drainage is used, whether it be intra-or extra-dural, special provision must be made for it. This is best secured by biting out, with rongeur forceps, a half-button of bone from the lower margin of the lowermost lamina in the flap (Fig. 8, E), and a corresponding half-button of bone from the upper margin of the uppermost one of the intact laminæ below (Fig. 8, F), so that when the osteoplastic flap is turned back into place, the two half-buttons will afford a circular bone-opening for drainage, the drains being conducted thence out through muscles and skin as just mentioned.

(14) After-treatment.—It is conceivable, though the writer knows of no such recorded case, that, through the excision of a large number of laminæ in the operation of laminectomy, a patient might be broken into two by subsequent rough or imprudent handling, so that it might be well, in even osteoplastic resection where the operation has been extensive, to include some form of spinal splint in the final dressing immediately after operation; which could be worn until solidification of the parts had taken place through union, as after any other fracture, the patient meanwhile maintaining a strictly horizontal posture. In ordinary osteoplastic resection of average extent, and with the spine normal as to strength, the use of a splint would seem superfluous. The writer has never used any

form of spinal support following laminectomy, where the spine is left even weaker than after an osteoplastic resection. If the need of it were felt, following the convalescence of the patient, some form of leather, or leather and metal, support could be worn as long as indicated. Reference has been made to the occasional need of such a support under General Considerations.

(15) Comment.—Both during and immediately following all operations in which the membranes of the cord are opened, the patient's head should be kept lower than the body and the spine absolutely horizontal, in order to lessen the loss of cerebrospinal fluid.

Where the window in the spine has been made too narrow, through the placing of the bone-sections too near together, if more space for manipulation be absolutely demanded, there is no alternative but to bite out a portion of the margin of the opening into the spine, by means of rongeur forceps or bone-cutting plics. If this be done to a limited extent, although there will be a corresponding gap when the osteoplastic flap is turned back into place, the flap will, nevertheless, be held in position and kept from pressing against the spine by resting upon the margins of the bone-section which have not been thus additionally cut away.

While the normal cord, in a normal canal, is not apt to be injured by any method of ordinarily careful approach, in pathological cases the need of additional care is always present.

When it is necessary to reach the anterior aspect of the spinal canal, the cord must be displaced temporarily to one side by means of gentle retraction. If such retraction should not give sufficient room for manipulation, one or two nerve-roots have been severed to afford the required additional room, and, at the end of the operation, sutured with fine plain catgut.

IV. The Technique of Laminectomy.—The nature of this operation has been briefly described under General Considerations. So many of the features of the operation of laminectomy are in principle common to the operation of osteoplastic resection, which has just been detailed at length, that only the

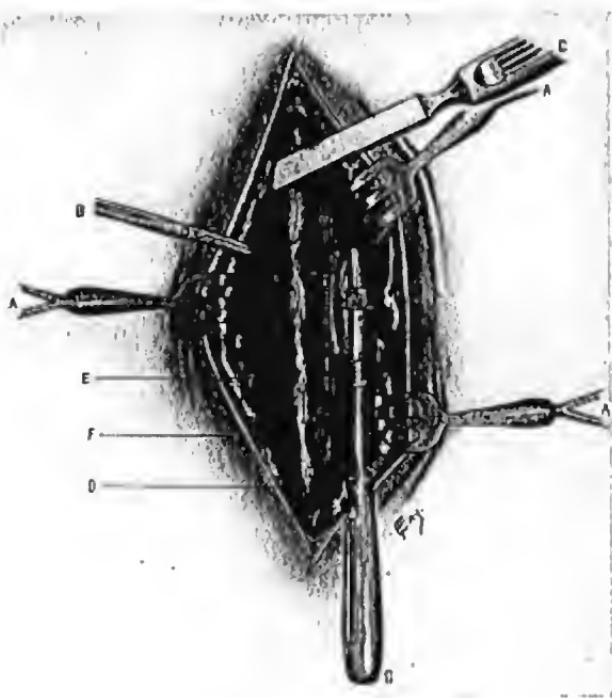


FIG. 10.—Laminectomy. A, A, A, Retractors withdrawing edges of wound; B, clamp-forceps controlling hemorrhage; C, chisel, against spinous processes as fulcra, levering soft part away from laminae; D, spine of vertebra; E, lamina; F, interlaminous ligament; G, Doyen saw completing section of laminae and interlaminous ligaments. (Drawn from cadaveric operation.) Note.—The feature of the subperiosteal operation is not shown here.

salient and distinguishing points of laminectomy will be here mentioned.

(1) Incision.—A median incision is made directly over the centres of the apices which are, together with their corresponding laminæ, to be removed. In order to give greater room for the exposure of these spines and laminæ, the incision should begin over the spine next above and end over the spine next below those to be removed (Fig. 4, C). It is a bad practice to place the vertical incision immediately to one side of the spines, in a line along which the muscles and aponeuroses are to be subsequently separated from the bone in the subperiosteal operation (or incised in the open, or non-subperiosteal, method); for if this be done, the median lip of this wound will have to be retracted to and beyond the line of the apices of the spines when the soft parts are freed from the side of the spine opposite to the one first attacked.

(2) Division of Muscles and Aponeuroses.—These structures are divided in the same general way, in so far as the direction of incising their structures is concerned, as described under Osteoplastic Resection, paragraph 2, and as indicated in Fig. 1, A and B. But as soon as the spines are reached, the knife should be wielded firmly and made to cut its way through the periosteum to the bone, in a straight median line over their posterior aspects, from the apex of each up to a point where the apex of the spine above prevents further incision of the periosteum. The subperiosteal method should always be undertaken unless specially contraindicated; but if it be elected not to attempt the subperiosteal operation, the knife should hug the spines so closely, in deepening the incision through the soft parts, that a minimum of muscle and aponeurotic tissue be left adherent to the bones.

(3) Subperiosteal freeing of Spines and Laminæ preparatory to their Division.—Having started up the edge of the incised periosteum from the apices and posterior aspects of the spines by means of a raspatory or periosteal elevator, this process of separation may be continued; or, better, a chisel, with its non-bevelled edge towards the parts to be removed

and its blade braced against the spinous processes (articular processes in the neck) as fulcra, is made to clear the soft parts from the spines and laminae. The edge of the chisel is carefully inserted beneath the freed margin of the periosteum, and is made to remove the periosteum first from the spines and then from the laminae, in the form of intact a layer as possible, and as adherent as possible to the overlying soft parts. As it is impracticable, in advance of clearing each spine and its set of laminae, to incise through the periosteum along the upper and lower borders of the spine and laminae, the layer of periosteum on each side, corresponding with each spine and the lamina of that side, must be more or less shredded and imperfect, especially where it merges into ligamentous tissue; but an attempt, nevertheless, should be made to preserve, even if in strips, enough periosteum from each spine and lamina to make the deposition of bone therefrom fairly likely. As mentioned under General Considerations, practically the only practical justification for performing laminectomy, ordinarily recognized by the writer, is the doing of the operation subperiosteally. (If the subperiosteal method be not elected, the freeing of spines and laminae is done in the same general way as in osteoplastic resection, except, in the present instance, that the chisel, with bevel towards the spines, is braced against the spinous processes as fulcra, and the soft parts are pried away from the spines and laminae towards the transverse processes (or articular processes in the neck). The method of manipulating the chisel is shown at C, Fig. 10, but the special feature of removing the periosteum together with the soft parts is not shown in this illustration. As a result of the procedures just described, a path is cleared for the saw, extending onto the lamina next above and the one just below those to be removed.

(4) Division of Laminae and Ligamenta Subflava.—Having removed the packing from the wound upon one side of the spines, its lip farther from the spinous processes is firmly retracted by two special retractors, thus exposing bared laminae (Fig. 10, A, A). The saw, held with its edge at a right angle to the surface of the laminae and somewhat nearer

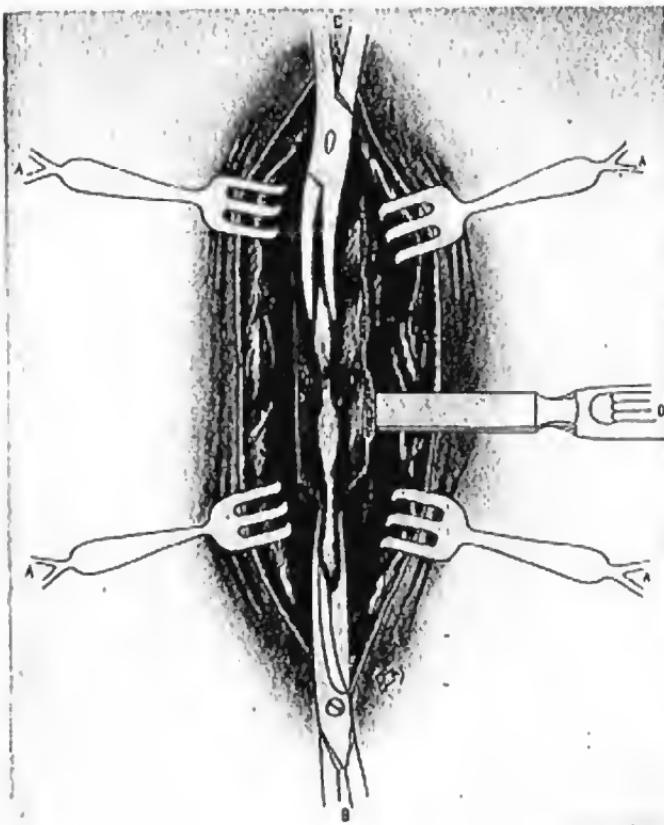


FIG. 11.—Laminectomy. A, A, A, A, Retractors separating edges of wound; B, curved scissors dividing intertransversus and interlaminous ligaments; C, bone-holding forceps grasping spines and supraspinous ligaments, to aid in lifting out the excised area of bone; D, chisel, against transverse processes as later, with edge in saw-cut, prying out the excised part. (Drawn from cadaveric operation.) *Note*.—The interlaminous ligament at the upper part of the wound should also be represented cut.

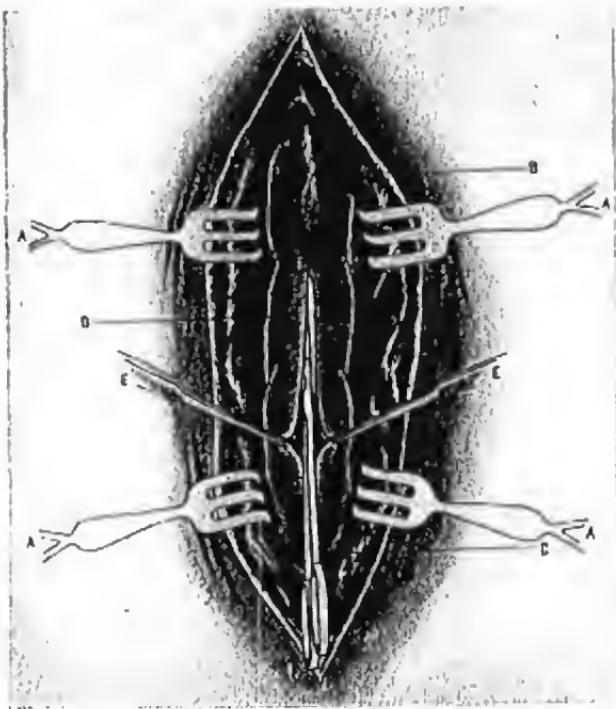


FIG. 12.—Laminectomy. A, A, A, A, Retractors holding apart margins of the wound; B, spinous process of vertebra above segment of spinal column removed; C, shelving lamina of intact vertebra below; D, cut surface of laminae; E, E, delicate forceps grasping membranes so as to form a transverse ridge; F, scissors in act of incising transverse ridge and continuation of membranes. (Drawn from cadaveric operation.)

the bases of the transverse processes (bases of the cervical articular processes) than the bases of the spines, is made to cut through the indicated laminae, as well as through one-half of the lamina next above and next below those to be removed (Fig. 10, G). The course of the saw and the completion of the section should be determined as in the osteoplastic resection.

(5) Division of Supraspinous, Interspinous, and Interlaminous Ligaments.—The above ligaments between the spines and laminae at the lower end of the section are divided with curved scissors, just as described in Osteoplastic Resection, and as illustrated in Fig. 11, B. In addition, the same ligaments are divided in the same manner at the upper end of the section. The segment of spines, laminae, and ligaments is thus entirely isolated by the saw-cuts on either side and the division of the ligaments above and below. In Fig. 11 the saw-cuts and the division below are alone shown.

(6) Separation and Removal of Ligamento-osseous Section.—Having well retracted the margins of the wound (Fig. 11, A, A, A, A), and determined that the sections through bone and ligaments are complete, the segment thus limited is ready to be pried from its bed. While the spines and connecting ligaments are grasped by bone-holding forceps (Fig. 11, C), a chisel, with its bevelled edge away from the parts to be removed, and its blade braced against the transverse processes (or cervical articular processes) as fulcra, is made by depressing its handle, to lever out the mass from its bed, aided by moderate traction upon the forceps grasping the spines. In the act of its removal, the mass is given a downward direction, so as to dislodge the uppermost laminae of the section from the laminae and spinous process of the last intact vertebra above (Fig. 12, B).

(7) Freeing of the Cord from Extradural Areolar Tissue, and Control of Intraspinal Haemorrhage.—These are accomplished exactly as in the Osteoplastic Operation described above, and partially illustrated in Fig. 8, G.

(8) Opening of the Membrane of the Cord.—This portion of the present operation is also accomplished in a manner

similar to that mentioned under the Osteoplastic Resection, and is pictured in Fig. 12, E, E, and F.

(9) Manner of Dealing with the Incised Membranes.—As in the Osteoplastic Operation.

(10) Deep Suturing of Muscles and Aponeuroses.—More care is here necessary than even in the osteoplastic resection. A large mass of tissue has been permanently removed, and the soft parts which were formerly in contact with the bones and ligaments which have just been removed are now to be brought into contact with each other and sutured together by deeply buried stout twenty-day chromic gut. In the apposition of these soft parts, whatever periosteum has been saved should be so manipulated as to be made to lie in as normal a relation as possible, so that whatever bony deposit occurs should take place as nearly as may be in the site of the missing laminae and spines, and thus strengthen the spinal column. Interrupted sutures probably accomplish this object better than a continuous form of suturing.

(11) Skin and Fascial Suturing.—A median continuous, or interrupted, suture of silkworm gut, or silk, should be placed through skin and fascia.

(12) Provision for Drainage, when indicated.—What applies in principle in osteoplastic resection also applies here. When temporary intraspinal drainage, whether intra- or extradural, is indicated, drains are readily conducted from within outward to the skin surface, through openings left in the soft parts between omitted sutures.

(13) After-treatment.—Here, much more than in Osteoplastic Resection, may it be indicated not only to include some form of splint in the dressing immediately following the operation, but also the wearing of some form of spinal support for several weeks or months following the operation, until the spinal column has solidified through the deposit of bone by the periosteum, or otherwise.

(14) Comment.—The observations made under the Osteoplastic Operation also apply here.